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BOTANY.—*The effect of salts of boron upon the distribution of desert vegetation.*[1] KARL F. KELLERMAN, Bureau of Plant Industry.

The disastrous experiences of the past two seasons in the use of fertilizers contaminated with varying percentages of borax[2] has sharply drawn attention to the importance of considering boron compounds not only in fertilizer investigations but in investigations of alkali deposits wherever agricultural developments are to be considered. While geologists are familiar with commercial developments of borax, it has not been generally appreciated by botanists or others interested in the vegetation of the desert regions that extensive deposits of borax are recorded in many localities in the western United States.

It is true that, in reports of early explorations of the West and Southwest, reference is made to the occurrence of borax and also to the barrenness of some of these regions. For example, the following quotation is made from the article[3] entitled "Borax in America" by W. O. Ayers, M. D.:

"A glance at the map of the State of Nevada shows a large number of dotted spots, individually of no great extent, scattered over the desert regions east of the Sierra Nevada. Most of them are without designation, but a few are marked 'Soda Flat,' 'Salt Marsh,' etc. They all have probably a common origin; they are places which long ago (how long we cannot tell) were covered with water, since removed by solar evaporation. Each consists of an extent of entirely flat sur-

[1] Address of the Retiring President (1919), of the Botanical Society of Washington, February 3, 1920. Received Aug. 24, 1920.

[2] SCHREINER, BROWN, SKINNER, and SHAPOVALOV. *Crop Injury by Borax in Fertilizers.* U. S. Dept of Agric. Circular 84.

[3] Popular Science Monthly 21: 358. 1882.

face of dried mud, sometimes absolutely bare, sometimes covered with saline deposits. It had been known for years that these deposits were both what is there universally called 'alkali' (carbonate of soda) and salt. But it was not until 1871 that much attention was drawn to the fact that several of them contained also deposits of borates, though published mention had been made some time earlier that these existed there.

"The number of these 'marshes,' which are marked by borate deposits, it is impossible to state, as so large an extent of that arid region remains as yet very imperfectly known."

The earliest records pointing to a rather wide distribution of compounds of boron on the Pacific Coast are shown in the following quotation from the Proceedings of the California Academy of Sciences, contribution by J. A. Veatch, January 17, 1859:

"The existence of boracic acid in the sea-water of our coast was brought to my notice in July, 1857. I had, in the month of January of the previous year, discovered borate of soda and other borates in solution in the water of a mineral spring in Tehama county, near the upper end of the Sacramento Valley. Prosecuting the research, I found traces of boracic acid—in the form of borates—in nearly all the mineral springs with which the State of California abounds. This was especially the case in the Coast mountains. . . . . .

". . . . . This led to an examination of the sea-water, and a detection of an appreciable quantity of boracic acid therein. It was at Santa Barbara, where I first detected it, and subsequently at various points, from San Diego to the Straits of Fuca. It seems to be in the form of borate of soda, and perhaps of lime. The quantity diminishes toward the North. It is barely perceptible in specimens of water brought from beyond Oregon, and seems to reach its maximum near San Diego.

"This peculiarity seems to extend no great distance seaward. Water taken thirty or forty miles west of San Francisco gave no trace of acid."

It is perhaps a question whether the desolate character of some of the western and southwestern deserts can be directly correlated with the occurrence of borax in quantity within these areas. Apparently no such correlation has been suggested, either by ecologists or by engineers or agriculturists interested in reclamation and irrigation problems in these regions. The Smoke Creek Desert, the Carson Desert, Death Valley, and the Mojave Desert are remarkable for their barrenness; and in view of the occurrence of borax in these regions, it would seem to be a fair question as to whether the contamination of borax in the soil might not be responsible to as great a degree as the low rainfall, for the absence

of vegetation. Furthermore, those familiar with the topography of these deserts will recall the peculiar absence of vegetation from mud flats even when these are gradually drying out; they occasionally dry into perfectly level plains, hard and smooth, apparently not badly troubled with alkali but with no sign of vegetation. These playa formations in the vicinity of Hazen and Fallon in the Truckee-Carson region, have been given more or less consideration with studies of the alkali difficulties of the Truckee-Carson irrigation project. While some of the reasons for the refractory character of these soils have been traced to the impermeability of soils,[4] other areas that appeared too low in total salt concentration to be dangerous to crop production were not complicated by unusual colloid problems and yet remained practically barren.

In view of the records of the rather wide distribution of borax in this region, it seems not unreasonable to suggest that the irregular and rather definitely located occurrence of borax may explain the injury to plants on these small areas. The number of localities in which commercial borax production has been attempted in the West will be surprising to most people. The areas in which commercial borax development has taken place within recent years or is now under way are well set out in the section on borax from the 1913 report on "Mineral Resources of the United States."[5]

It should be remembered, however, that the deposits of borax ordinarily are not recorded either by the geologists or commercial prospectors unless of considerable magnitude. It is not improbable, therefore, that the areas now recorded as showing borax report only a small fraction of the deposits which, from an agricultural or botanical point of view, are of prime significance. From the data reported by Mr. Yale and Mr. Gale, and from reports of other investigators, the following list apparently represents the areas in the United States where compounds of boron have been found.

[4] KELLERMAN, KARL F. *The relation of colloidal silica to certain impermeable soils.* Science 33: 189. 1911.

[5] YALE, CHARLES G., and GALE, HOYT S. *The production of borax in 1913.* Mineral Resources of the U. S., 1913—Part II. 1914.

CALIFORNIA: Furnace Creek, Death Valley; old abandoned borax claims in the Amargosa Canyon; colemanite discovered in Tick Canyon, a branch of Soledad Canyon, 40 miles north of the city of Los Angeles, and 5 miles from Lang Station, on the Southern Pacific; Slate Range Marsh, San Bernardino; in Inyo County 100 miles north of the Slate Range District; at the mouth of Furnace Creek and Resting Springs in Death Valley; Mono Lake; Owens Lake; Clear Lake; small quantities in spring at Red Bluff, Tehama County; Tuscan Springs, Tehama County, 8 miles east of Red Bluff; near the mouth of the Pitt River; 40 miles north of the Tuscan Springs several similar localities too small to be of any practical importance; a reconnaissance of the "coast range" of mountains, from the neighborhood of Shasta over a length of some 30 miles towards the South brought to light borates in the numerous small springs abounding in that locality but only in minute quantities; other localities between Clear Lake and Napa City; in Siegler Valley there is a hot spring containing borate of strontia and other borate salts; a borate spring in Suisan Valley; Kern County, 10 miles from Kalienti; 20 miles west of San Bernardino ulexite occurs in the Cane Spring District; Lake Elsinore, Riverside County.

NEVADA: Ulexite occurs abundantly in the Arizona Desert, and near Wadsworth, Nevada; on the eastern slope of the Sierra Nevada, near Walker's Pass, borax is found; also in Panamint and Death Valley in Lower Nevada; borax found in Esmeralda County in Fish Lake Valley, Clayton Valley, Big Smoky Valley (locally known as the San Antonio Marsh, in the Silver Peak Quadrangle), Teels Marsh, Rhodes Marsh, Fish Lake Pond; at Sand Springs in Churchill County, 100 miles from Columbus Marsh; Hot Springs, 50 miles farther to the northwest; mud lakes in the western part of the State, one in the vicinity of Ragtown, Churchill County; in Humboldt, Land, Whitepine and Lincoln Counties there are beds of salt containing borax.

OREGON: Curry County; Harney County, extending over 10,000 acres south of Lake Algord.

WYOMING: Salts in Union Pacific Lakes, called Big Lake, Track Lake, and Red Lake, vary from $1\frac{1}{2}$ parts per thousand to $\frac{3}{4}$ part per thousand of borax.

In addition to these localities, I have personally collected small samples in the alkali spots in Kern County, Calif., where plants were either dying or completely absent. Borax percentages of

significant size were found in these samples, although, with the rather high content of the white alkali salts in these spots, it is difficult to determine the relative importance of borax and the other salts in the alkali injury. Somewhat similar conditions exist in regard to Lake Elsinore, in Riverside County. The water of Lake Elsinore shows an appreciable percentage of borax and this suggests the possibility that the destructive injury following the use of Lake Elsinore water in irrigation may be partly due to borax poisoning, as well as to injury from other alkali salts. In this connection it is worthy of note that the lakes of the Southwest, famous for the remarkable clearness of the water, in many cases at least are more or less strongly impregnated with borax. It is true that the salt content in Lake Elsinore is high in relation to the percentage of borax; in the case of Clear Lake, Owens Lake, and Mono Lake, the comparison with the other salts is much higher. I am inclined to suggest, therefore, that wherever there are lakes in which the temperature of the water is sufficient for satisfactory development of aquatic plants but which remain free of vegetation, they should be prospected for the possible occurrence of borax.

Plant physiologists have frequently included boron compounds in determining the toxicity of various compounds upon plants, both in water cultures and in sand and in soil. As is the case with the very scattered literature dealing with field applications of borax to crop plants, there are some contradictions and differences of opinion regarding the toxic action both of borax and other boron compounds. A fairly complete review of this literature up to 1914 has been published by Dr. Brenchley, of the Rothamsted station. Following this review Dr. Brenchley concludes that boric acid seems to be less harmful to the higher plants than compounds of copper, zinc, and arsenic; and, further, that below a certain amount of concentration boron compounds exert a favorable influence upon plant growth.

From a review of much of the literature reported upon, I am inclined to doubt the validity of this last opinion, considering

the stimulating effect to be due to a suppression of the growth of competing organisms such as bacteria and molds on the control plants of water cultures and the bacteria and protozoa in the sand and soil cultures. It may be doubted also whether the conclusion regarding the relative toxicity of boron compounds and compounds of zinc and copper is valid. If one is considering plants growing in natural soil, zinc and copper compounds are certain to become transformed into insoluble compounds much more rapidly and completely than is the case with boron form deposits that represent natural accumulations. Therefore, it may not unfairly be presumed that boron will prove to be a more toxic element than either zinc or copper.

The toxicity of boron compounds to different crops under field conditions has not been adequately investigated. It will almost certainly be found that different crops will show a great range in their resistance to borax poisoning, and it is probable that there may be found to be some direct correlation between the action of the plant in absorbing boron compounds and the limit of the toxic concentrations. In rather extensive experiments upon the effect of manure treated with different compounds of boron, Dr. Cook makes the following statement:[6]

"It apparently made little difference in the quantity of boron absorbed by the plants tested whether boron was added to the soil as borax or as calcined colemanite. The addition of lime with borax had no definite effect in preventing the absorption of boron. Wheat and oats absorbed very little boron, while leguminous and succulent plants absorbed comparatively large amounts."

It seems clear that much additional investigation, both in the field and laboratory, is necessary before it will be possible to determine the significance of borax either in its relation to natural vegetation or its bearing upon agricultural development in irrigation projects or in the use of fertilizers. In taking up new studies it should be emphasized, however, that the investigator should not remain blind to other compounds that might prove even more important in their relation to vegetation than compounds of boron; for example, in several of the regions where borax has been produced commercially, quicksilver ores also occur.

[6] Cook, F. C. Journ. of Agric. Res. 5: 888.

MINERALOGY.—*The nomenclature and classification of sulfide minerals.* EDGAR T. WHERRY, Washington, D. C.[1]

In a paper published in this JOURNAL over 3 years ago[2] the writer put forward a plan for the nomenclature and classification of the native elements, based in a general way upon that followed in Dana's System of Mineralogy (6th edition), but differing in certain important respects. The fundamental rules of nomenclature are as follows: If only one form of an element is known, the chemical name is used; polymorphous forms are named by applying crystallographic adjectives to the chemical names; and varieties based on isomorphism are also described by adjectives, constructed by adding the suffix *iferous* to the names of the elements present in the lesser amounts. The rules for classification are: Two main divisions, non-metals and metals, are recognized, and these are subdivided into groups on a strictly crystallographic basis. For use with minerals composed of two or more elements in combination, this plan obviously requires some modification, and in the present paper a set of rules applicable to the sulfides and related minerals is formulated.

Nomenclature.—The name first proposed for each mineral is adopted, foreign names being translated or transliterated. The ending *ite* is added in every case, except where some name without such ending is in common use. Separate mineral names are used for polymorphous forms.[3] In minerals in which one element is clearly essential and others replace it isomorphously, in widely varying but never significant amounts, the plan adopted in the preceding paper is followed: the name of the replacing element, with the suffix *iferous*, is used as an adjective. On the other hand, in minerals which belong to complete isomorphous series, single names are given to the series, and separate ones to

[1] The data for this paper were assembled while the writer was Assistant Curator of the Division of Mineralogy and Petrology in the U. S. National Museum. Received July 26, 1920.

[2] This JOURNAL 7: 447–456. 1917.

[3] The use of Greek-letter prefixes, which has certain advantages, has not been introduced systematically, since it is ordinarily limited to discussions of stability, relationships, etc.

their end-members, if these are well known as individual species.

Classification.—With the sulfides proper are ranged all other compounds of analogous character, comprising not only the selenides, tellurides, arsenides, antimonides and bismuthides, usually so treated, but also the oxysulfides, nitrides, phosphides, carbides, and silicides, which are not as a rule assigned any definite status. These are separated first on the basis of the metallic or non-metallic character of the more basic element concerned, and next into chemical divisions, depending on the ratios of the basic to the acidic elements present. The divisions are finally subdivided into groups on a crystallographic basis, as was done with the elements. As before, the order in which groups are taken up is that of decreasing crystallographic symmetry (trigonal, however, preceding tetragonal), the final group in most divisions including amorphous, colloidal, and cryptocrystalline, meta-colloidal, members, together with those of which the crystallization is as yet unknown; and the order of the individual minerals within the groups is based on the positions of the constituent elements in the Periodic System.

While there is nothing particularly novel about these rules, they do not appear to have been applied consistently heretofore. In the present work exceptions are admitted only for especially urgent reasons, and the tabulation, which follows, is accordingly uniform and systematic to an unusual degree. Discussion leading to its further improvement is, however, invited.

The first column of the table contains the names of the species and varieties recognized, worked out in accordance with the above principles. No new names are proposed in this paper, although a few old ones are redefined. The second column contains the composition of each; isomorphous replacement[4] is repre-

[4] Isomorphism was formerly considered to exist between single bivalent elements and pairs of univalent ones (for instance, Pb and Ag_2) but recent studies have shown supposed instances of this to be mixtures. Only isomorphous replacement of elements of like valence is here admitted. It may also be noted that the argentite and galena groups are here widely separated, since their structures must be entirely different.

sented by a comma, the element present in largest amount being placed first; and in the case of complete isomorphous series and double compounds the formulas are written separately, with a period between, not implying any particular interpretation of structure of the crystal, but so as to bring out to the best advantage the numerical relationships between the constituents. Variability in composition aside from typical isomorphism is frankly admitted, and a dash placed between the numbers representing the limiting amounts of the variable elements. The third column contains explanations of changes from current usage, important synonyms, references for minerals omitted by Dana, etc.

SULFIDES, OXYSULFIDES, SELENIDES, TELLURIDES, AND CARBIDES OF NON-METALS AND SEMI-METALS

X: 1 DIVISION.....	New; ratio X ranging from 1+ to 3.
WEHRLITE GROUP. TRIGONAL...	New; placed by Dana after the "stibnite group," but the formula-type is quite different.
Wehrlite.....$Bi_{1-2}(Te,Se,S)$	Synonyms: "gruenlingite," "joseite," (Dana No. 32), "oruetite," and "pilsenite;" composition widely variable.
NON-CRYSTALLIZED GROUP.....	New.
(Hydrocarbons).....H_xC	Chiefly cryptocrystalline.
Quisqueite.....$C_{2-4}S$	Has been grouped with native elements, but is apparently a compound; amorphous, colloidal.
4:3 DIVISION.....	New.
DIMORPHITE GROUP. ORTHORHOMBIC.....	New.
Dimorphite.....As_4S_3	Has been confused with orpiment, but is evidently distinct.
1:1 DIVISION.....	New.
MOISSANITE GROUP. TRIGONAL-HEMIMORPHIC.....	New.
Moissanite.....SiC	Meteoritic; the name "carborundum" has priority, but was proposed for an artificial product.
REALGAR GROUP. MONOCLINIC.	
Realgar.....AsS	

2:3 DIVISION.....New.

TETRADYMITE GROUP. TRIGONAL..Separated but not named by Dana.

Tetradymite.....$Bi_2S_3.2Bi_2Te_3$

Tellurobismuthite...Bi_2Te_3 — Dana's "tetradymite, variety 1;" name a translation of "tellurwismuth."

HYDROUS ARSENIC SULFIDE. GROUP. TETRAGONAL.....New.

(Hydrous arsenic sulfide).....$As_2S_3.H_2O$ — Described, without name, by E. Monaco, *Ann. Scuoli Agric. Portici*, [2], 4: 7–11. 1903. Sometimes indexed by the German name "arsenschwefel," but this is not a satisfactory mineralogical term.

STIBNITE GROUP. ORTHORHOMBIC.

Orpiment.....As_2S_3 — Crystallization monoclinic, but peri-rhombic.

Kermesite.....$Sb_2O_3.2Sb_2S_3$ Included here for simplicity.

Stibnite.....Sb_2S_3 "Antimonite."

Bismuthinite.....Bi_2S_3

Antimoniferous var.....$(Bi,Sb)_2S_3$ — Distinctness affirmed by Murdoch, *Micr. detn. opague min.*, p. 131. 1916.

Guanajuatite.....$Bi_2S_3.2Bi_2Se_3$

Selenobismuthite....Bi_2Se_3 — Name an abbreviated translation of "selenwismuthglanz."

NON-CRYSTALLIZED GROUP.....New.

(Amorphous orpiment).....$As_2S_3.xH_2O$ — Probably the form of arsenic sulfide which occurs in hot-spring deposits; not yet assigned a special name; not in Dana.

Metastibnite.....$Sb_2S_3.xH_2O$ Amorphous, colloidal.

Karelinite.....$Bi_2O_3.2Bi_2S_3$ — "Bolivite;" an oxysulfide of uncertain homogeneity; classed by Dana as a variety of bismite.

1:2 DIVISION.....New.

MOLYBDENITE GROUP. TRIGONAL.

Molybdenite.....MoS_2

NON-CRYSTALLIZED GROUP.....New.

Jordisite.....MoS_2 — Cornu, *Z. Chem. Ind. Kolloide*, 4: 190, 1909; (not in Dana); amorphous, colloidal.

Tungstenite.....WS_2

1:X DIVISION.....New; ratio X ranging from 1+ to 6

NON-CRYSTALLIZED GROUP.....New.

Arsensulfurite.....AsS_{4-6} — Sometimes grouped with the native elements, but the constituents seem likely to be combined.

Patronite.....VS_{3-4}

SULFIDES, OXYSULFIDES, SELENIDES, TELLURIDES, NITRIDES, PHOSPHIDES, ARSENIDES, ANTIMONIDES, BISMUTHIDES, CARBIDES AND SILICIDES OF METALS

X:1 DIVISION		New; ratio X ranging from 3 to 11; part of Dana's "basic division."
COHENITE GROUP. ISOMETRIC		New; included by Dana with native elements, but evidently compounds.
Cohenite	$(Fe,Ni)_{3-4}C$	Meteoritic; includes "chalypite."
STUETZITE GROUP. HEXAGONAL		New.
Stuetzite	$Ag_{3-4}Te$	
SCHREIBERSITE GROUP. TETRAGONAL.		New; included by Dana under isometric native elements.
Schreibersite	$(Fe,Ni)_{3-4}P$	Meteoritic; includes "rhabdite."
NON-CRYSTALLIZED GROUP		New.
Whitneyite	Cu_9As	"Darwinite;" homogeneity affirmed by Murdoch, *op. cit.*, p. 74, but discredited by Borgström, *Geol. för. förh.* **38**: 95. 1916.
Algodonite	Cu_6As	Homogeneity affirmed by Borgström, *loc. cit.*, but questioned by Murdoch, *op. cit.*, p. 37.
Horsfordite	Cu_6Sb	Homogeneity affirmed by Murdoch, *op. cit.*, p. 135.
Chilenite	$Ag_{11}Bi$	The formula Ag_6Bi often given does not agree with the analyses; homogeneity affirmed by Murdoch, *op. cit.*, p. 125.
3:1 DIVISION		New; part of Dana's "basic division."
DYSCRASITE GROUP. ORTHORHOMBIC.		
Domeykite	Cu_3As	Crystallization peri-hexagonal; includes "condurrite," "keweenawite," "ledouxite," "mohawkite," "orileyite," "stibiodomeykite," etc., the heterogenous character of most of which has been shown by Murdoch, *op. cit.*, pp. 38–39.
Arsenargentite	Ag_3As	"Huntilite."
Dyscrasite	Ag_3Sb	"Stibiotriargentite;" includes "animikite," "chanarcillite" and "stibiohexargentite," impure forms.
5:2 DIVISION		New; ratio somewhat variable.
NON-CRYSTALLIZED GROUP		New.
Bismuthaurite	$Au_{2-3}Bi$	"Maldonite;" included by Dana with native elements, but has as much right to be called a compound as other members of this division.
Ferrosilicite	$Fe_{2-3}Si$	Meteoritic; Shepard, *Amer. Jour. Sci.* [1] **28**: 259. 1859.

Siderazotite.....Fe_3N_2	"Silvestrite;" ending *ite* added for uniformity; included by Dana with native elements, but evidently a compound.
2:1 DIVISION.....	New; part of Dana's "monosulfides, ..."
ARGENTITE GROUP. ISOMETRIC..	New; part of Dana's "galena group."
(Isometric chalcocite).....Cu_2S	The stable form at high temperatures, probably represented in massive occurrences of "chalcocite;" not yet assigned a separate name.
Eucairite.....$Cu_2Se.Ag_2Se$	
Argentite.....Ag_2S	"Jalpaite;" distinctness affirmed by Murdoch, *op. cit.*, p. 140.
Cupriferous var.$(Ag,Cu)_2S$	
Aguilarite.....$Ag_2(S,Se)$	Compare Quercigh, *Riv. min. crist. Ital.*, 44: 26. 1915.
Naumannite.....Ag_2Se	
Hessite.....Ag_2Te	
CHALCOCITE GROUP. ORTHORHOMBIC.	
Chalcocite.....Cu_2S	
Stromeyerite.....$Cu_2S.Ag_2S$	
Acanthite.....Ag_2S	
NON-CRYSTALLIZED GROUP.....	New.
Berzelianite.....Cu_2Se	
Crookesite.....$7Cu_2Se.Tl_2Se$	
(Amorphous argentite).....Ag_2S	Occurrence in nature affirmed by Cornu. *Z. Chem. Ind. Kolloide* 4: 187. 1909; not in Dana; not yet named.
Petzite.....$3Ag_2Te.Au_2Te$	
4:3 TO 8:5 DIVISION.....	New.
BORNITE GROUP. ISOMETRIC....	New.
(Isometric high-sulfur chalcocite).....$Cu_2S_{1-1.2}$	Compare Posnjak, Allen, and Merwin, *Econ. Geol.* 10: 492. 1915; not yet named.
Bornite.....Cu_4FeS_4	The old formula Cu_3FeS_3, has been discredited.
MAUCHERITE GROUP. TETRAGONAL.....	New.
Maucherite.....Ni_2As_2	"Placodine," artificial; "temiskamite;" the formula has been suggested to be Ni_4As_3 by Palmer, *Econ. Geol.* 9: 664. 1914.
HIGH-SULFUR CHALCOCITE GROUP. ORTHORHOMBIC.....	New.
(High-sulfur chalcocite).....$Cu_2S_{1-1.2}$	Compare Posnjak *et al, loc. cit.*; not yet named.

NON-CRYSTALLIZED GROUP.....		New.
Umangite.....	Cu_3Se_2	
Rickardite.....	Cu_4Te_3	
Kalgoorlite.....	$(Ag,Au,Hg)_2Te_2$	Homogeneity uncertain.
1:1 DIVISION.....		New; part of Dana's "monosulfides. . ."
GALENITE GROUP. ISOMETRIC...		Part of Dana's "galena group."
Oldhamite.....	CaS	Meteoritic, placed by Dana after sphalerite group, but not tetrahedral.
Galenite.....	PbS	"Galena."
Clausthalite.....	PbSe	Includes "zorgite" (Dana No. 52), an impure form.
Altaite.....	PbTe	
Pentlandite.....	xFeS.yNiS	Placed by Dana after sphalerite group, but not tetrahedral; regarded as an isomorphous series; end-members unknown.
SPHALERITE GROUP. ISOMETRIC-TETRAHEDRAL.		
Sphalerite.....	ZnS	"Cleiophane."
Cadmiferous var	(Zn,Cd)S	"Przibramite."
Ferriferous var..	(Zn,Fe)S	"Blende;" includes "marmatite," "cristophite," etc., high-iron varieties.
Metacinnabarite.....	HgS	
Tiemannite.....	HgSe	
Alabandite.....	MnS	
COVELLITE GROUP. HEXAGONAL.		Dana's "cinnabar-wurtzite-millerite group" is here separated into several on the basis of crystallization.
Covellite.....	CuS	
Troilite.....	FeS	Meteoritic; owes its 1:1 ratio to its formation in the presence of excess iron.
Niccolite.....	NiAs	
Arite.....	xNiAs.yNiSb	An isomorphous series.
Breithauptite.....	NiSb	
WURTZITE GROUP. HEXAGONAL-HEMIMORPHIC.		
Wurtzite.....	ZnS	
Manganiferous var.....	(Zn,Mn)S	"Erythrozincite;" distinctness affirmed by Murdoch, *op. cit.*, p. 148.
Greenockite.....	CdS	
MILLERITE GROUP. TRIGONAL-RHOMBOHEDRAL.		
Millerite.....	NiS	Includes "beyrichite" (Dana No. 76).

GUADALCAZARITE GROUP. TRIGONAL-HEMIMORPHIC.		
Guadalcazarite	HgS	Has been confused with metacinnabarite, but differs in crystallization and important physical properties; compare the writer, *Amer. Min.* **5**: 35. 1920.
CINNABARITE GROUP. TRIGONAL-TRAPEZOHEDRAL.		
Cinnabarite	HgS	The ending *ite* is added for uniformity.
HAUCHECORNITE GROUP. TETRAGONAL		New.
Hauchecornite	4NiS.NiBi	Composition uncertain.
CHALCOPYRITE GROUP. TETRAGONAL-SPHENOIDAL		Marked off though not named by Dana.
Chalcopyrite	CuS.FeS	Includes "barnhardtite," "barracanite," "cubanite" (Dana No. 81) and "cupropyrite," impure forms, Murdoch, *op. cit.*; formerly regarded as a cuprous-ferric sulfide, but X-ray study shows the Cu and Fe to have analogous positions.
Stannite	2CuS.SnS.FeS	
Zinciferous var.	2CuS.SnS.(Fe,Zn)S.	
CHALMERSITE GROUP. ORTHORHOMBIC		New.
Chalmersite	CuS.2FeS	
Empressite	AgTe	
Muthmannite	xAgTe.yAuTe	"Krennerite" in part.
Teallite	SnS.PbS	
(Orthorhombic pyrrhotite)	FeS	Artificial; "α-pyrrhotite."
NON-CRYSTALLIZED GROUP		New.
(Amorphous covellite)	CuS	Occurrence in nature affirmed by Cornu, *loc. cit.*; not in Dana; not yet named.
Voltzite	ZnO.4ZnS	Included here for simplicity.
(Amorphous sphalerite)	ZnS	Mentioned but not named by Dana.
Xanthochroite	CdS.xH$_2$O	Rogers, *Journ. Geol.* **25**: 524. 1917.
(Amorphous cinnabarite)	HgS	Occurrence in nature affirmed by Cornu, *loc. cit.*; not in Dana; not yet named.
Onofrite	5HgS.HgSe	
Coloradoite	HgTe	
Lehrbachite	xHgSe.yPbSe	An isomorphous series.
Hydrotroilite	FeS.xH$_2$O	Sidorenko, *Mem. soc. nat. Nouv. Russie* **24**: 97, 1901; *Neues Jahrb. Min. Geol.* **1902**, II, ref. 397; not in Dana.
Jaipurite	CoS	

5:6 TO 3:4 DIVISION		Part of Dana's "intermediate division."
LINNEITE GROUP. ISOMETRIC		Marked off but not named by Dana.
Linneite	$CoS.Co_2S_3$	"Linnaeite;" includes "carrollite" (Dana No. 82), shown to be a mixture by Murdoch, *op. cit.*, p. 37; also "sychnodymite," which is apparently similar; compare Zambonini, *Riv. min. cryst. Ital.* **47**: 40. 1916.
Siegenite	$x(CoS.Co_2S_3).y(NiS.Ni_2S_3)$	Regarded as an isomorphous series, of which the preceding and following are end members.
Polydymite	$NiS.Ni_2S_3$	Has been assigned another formula, but the analyses agree as closely as could be expected with this one.
PYRRHOTITE GROUP. HEXAGONAL		New.
Pyrrhotite	$FeS_{1\text{-}1.2}$	"β-pyrrhotite."
STERNBERGITE GROUP. ORTHORHOMBIC		New.
Sternbergite	$AgFe_2S_{3\text{-}4}$	"Argentopyrite," "frieseite," etc.; composition not certain; compare Zambonini, *loc. cit.*
Leucopyrite	$FeAs.Fe_2As_3$	Included by Dana under loellingite, but apparently independent.
Daubreelite	$FeS.Cr_2S_3$	Meteoritic; shows cleavage in one direction
1:2 DIVISION		Dana's "disulfides....."
PYRITE GROUP. ISOMETRIC-PYRITOHEDRAL		Part of Dana's "pyrite group."
Hauerite	MnS_2	
Pyrite	FeS_2	
Nickeliferous var	$(Fe,Ni)S_2$	"Bravoite;" the so-called "cobalt-nickel-pyrite" contains cobalt also.
Arsenoferrite	$FeAs_2$	
Smaltite	$CoAs_2$	Includes "bismutosmaltite" and "chathamite," apparently mixtures.
Cloanthite	$NiAs_2$	This and the preceding form limited isomorphous mixtures, but the series has not received a separate name.
Laurite	RuS_2	
Sperrylite	$PtAs_2$	
COBALTITE GROUP. ISOMETRIC-TETARTOHEDRAL		New; includes minerals of this division containing two different non-metals; compare Bragg, X-rays and Crystal Structure, p. 154. 1916.

(Tetartohedral pyrite)	$Fe(S,X)_2$	The variety of pyrite showing this symmetry probably contains arsenic or some other element isomorphously replacing part of its sulfur.
Cobaltite	CoSAs	
Gersdorffite	NiSAs	Includes "corynite" (Dana No. 91), an impure variety.
Ullmannite	NiSSb	
Willyamite	CoSSb	This and the preceding form limited isomorphous mixtures.
Kallilite	NiSBi	
MARCASITE GROUP. ORTHORHOMBIC.		
Krennerite	$xAgTe_2.yAuTe_2$	An isomorphous series.
Calaverite	$AuTe_2$	
Nagyagite	$(Pb,Au)(S,Te,Sb)_2$	Composition uncertain.
Marcasite	FeS_2	
Arsenopyrite	FeSAs	"Mispickel."
Loellingite	$FeAs_2$	
Glaucodotite	$xCoSAs.yFeSAs$	The ending *ite* is added for uniformity; includes "danaite" and "alloclasite" (Dana No. 102), an impure form, Murdoch, *op. cit.*, p. 37.
Safflorite	$CoAs_2$	Includes "badenite," apparently an impure form.
Wolfachite	NiSAs	Only known in impure form.
Rammelsbergite	$NiAs_2$	
SYLVANITE GROUP. MONOCLINIC.		
Sylvanite	$AgTe_2.AuTe_2$	Includes "goldschmidtite," a variety of unusual habit.
Melonite	$NiTe_2$	
NON-CRYSTALLIZED GROUP	New.	
Melnikovite	$FeS_2.xH_2O$	In part amorphous and in part metacolloidal, cryptocrystalline.
1:X DIVISION	New; ratio X ranging from 2+ to 3.	
SKUTTERUDITE GROUP. ISOMETRIC PYRITOHEDRAL	New.	
Skutterudite	$CoAs_{2-3}$	Includes much so-called "smaltite."
(High-arsenic cloanthite)	$NiAs_{2-3}$	Analogous to the preceding; not yet assigned a separate name.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

830TH MEETING

The 830th meeting was held at the Cosmos Club, February 14, 1920. President SOSMAN presided and 38 persons were present.

The first paper by Messrs. W. F. MEGGERS and PAUL D. FOOTE on *A new microphotometer for photographic densities* was presented by Mr. MEGGERS.

The new microphotometer for measuring photographic densities is essentially the micropyrometer described in the Bulletin of the Bureau of Standards (**9**: 475. 1913) except that a microscope of higher power is used. The photographic plate is mounted just below the objective of the microscope on a horizontal bed movable with a graduated screw and is illuminated beneath by an intense beam of light from a tungsten ribbon lamp. Light transmitted by a small portion of the photographic plate, the image of which is adjacent to that of the tip of the pyrometer lamp, is matched with equal filament brightness by adjusting the current through the lamp. The ammeter readings are readily translated into measurements of photographic densities. If the tip of the pyrometer lamp filament be regarded as a filar in the eye-piece, the relative positions or wave lengths of spectral lines on a plate are measured at the same time that their photographic densities are measured.

An example of the use of this microphotometer for measuring wave lengths and densities of spectral lines is given and it appears that the visually estimated intensities of such lines are a geometric series in accordance with Fechner's law.

Illustrations of this microphotometer's application to the measurement of energy distribution in a broad spectral line and to the measurement of spectral sensitivity of a photographic plate are given.

Measurements of photographic density when the plate is illuminated by parallel light are found to be much larger than when the illumination is diffuse. This experience calls attention to the importance of specifying the character of the illumination when measurements are made on light transmission of diffusing media. The paper was illustrated by lantern slides.

Discussion.—The paper was discussed by Messrs. SOSMAN and HUMPHREYS.

The second paper, also by Messrs. FOOTE and MEGGERS, was presented by Mr. FOOTE. The title was *Atomic theory and low-voltage arcs in caesium vapor.* The paper was illustrated by lantern slides. Full publication may be found in Phil. Mag. Series 6, **40**: 80. 1920.

The above paper was discussed by Messrs. SOSMAN and TUCKERMAN.

The final paper by Messrs. E. F. MUELLER and M. S. VAN DUSEN, on *Heat of combustion of volatile liquids*, was presented by Mr. MUELLER. The paper was illustrated by lantern slides and the burner used by the authors was exhibited. Messrs. FOOTE and SOSMAN discussed this paper.

831ST MEETING

The 831st meeting was held at the Cosmos Club March 13, 1920, with President SOSMAN presiding and 60 persons present.

The first paper was by Mr. E. D. WILLIAMSON on *Earthquakes and the elastic properties of the earth.*

Data from geographic and astronomic sources have established some qualitative measure of the earth's rigidity, average density, and the distribution of the earth's mass. Earthquake records, properly interpreted, give us an immediate check on the conclusions which have been reached.

Two of the types of waves propagated as the result of a seismic disturbance travel through the earth with velocities in each case inversely proportional to the square root of density but depending in one case on the rigidity and in the other on both the compressibility and rigidity. It is necessary then to find the relation of the velocity of the wave to the depth beneath the surface of the earth to get further information as to the variation of these other quantities. Wiechert at Gottingen first solved the problem by graphical means, but since then more direct analytical methods have been developed to find from a transit-time curve, the path of the wave through the earth and its velocity at various points.

The results to which the writer and L. H. ADAMS were led by their investigations are outlined in the second paper, presented by Mr. L. H. ADAMS on *The nature of the interior of the earth.* It has long been known that since the average density of the earth (5.5) is so much higher than the density of ordinary surface rocks, the central portion must have a very high density—probably 10.0 or more. To account for this interesting fact we may assume either that the center of the earth is composed of relatively heavy forms of matter or that the extreme pressures in the interior—two or three millions of atmospheres—have compressed the ordinary rock material to one-third to one-quarter of its original volume. With regard to the second hypothesis, we have no information to guide us in forming an opinion concerning the behavior of matter at these enormous pressures so far beyond the range of laboratory experimentation. Fortunately, however, the data on the propagation of distant earthquakes may be made to shed some light on this important question. Starting with the known velocity v of the transverse vibrations at the distance r from the center of the earth, the density ρ produced by *compression* alone may be calculated by graphical integration and successive approximation, using the equation:

$$\log_e \frac{\rho}{\rho_o} = h \int_{r_o}^{r} \frac{m}{r^2 v^2} \, dr$$

in which m denotes the mass contained within the sphere of radius r, and h is a constant.

The results of this operation show that it is impossible to account for *all* of the excess density in the interior by *compression* alone. It does account for a surprisingly large part of it, however. The difference must be attributed to a segregation toward the center of heavy material, presumably metallic iron, and we thus have a quantitative measure of the amount of this segregation.

Finally, mention is made of the fact that from the center of the earth out to about 0.5 of the distance to the surface, the properties of the material composing this central portion of the earth are such that transverse vibrations are not transmitted. This part of the earth, therefore, is lacking in rigidity; in other words, it is not a solid and therefore must be considered in spite of its high density to be either a gas or a liquid, depending on whether or not the temperature is above the critical point, liquid-vapor, of the material.

Both the above papers were illustrated by lantern slides.

Discussion.—Both the above papers were discussed after the reading of the second, Messrs. BEALL, SPENCER, BOWIE, LAMBERT, HUMPHREYS, TODD, HAWKESWORTH, and SOSMAN participating in the discussion.

The last paper of the evening by Messrs. H. C. DICKINSON and C. H. MEYERS on *A 15-atmosphere manometer and a 100-atmosphere piston gage* was presented by Mr. DICKINSON.

A fifteen-atmosphere mercury manometer and a one hundred-atmosphere piston gage were described. The manometer consists of five glass U-tubes 250 cm. long, connected in series, each of which may be by-passed by a valve. Four of these tubes may be used to measure multiples of three atmospheres, while any fraction of three atmospheres may be measured on the fifth. To avoid rusting of steel parts and fouling of mercury surfaces, pure ethyl alcohol is used to transmit the pressure, between tubes. The pressure transmitting liquid may be admitted into the manometer between any two U-tubes. The temperature of the manometer is measured by a thermometer which has a bulb located behind the center of the manometer and of the same length as the U-tubes. The accuracy of the manometer-temperature measurement is improved by an air circulating fan which keeps the room temperature very uniform.

The piston gage consists of a hardened steel piston of approximately one square centimeter area, floating on oil inside a hardened selel cylinder. A dead weight load is applied to this piston through a plunger specially designed to transmit only a vertical force component to the piston. For the purpose of cutting down leakage past the piston at higher pressures, the cylinder has been made with a re-entrant part which encircles the piston so that the pressure is applied to the outside as well as the inside of the cylinders. A mechanical device has been applied which rotates the piston slowly, without producing any uncertain

axial forces exceeding 0.05 gram under regular operating conditions. An auxiliary U-tube partly filled with mercury, separates the oil in the gage from the pressure to be measured and indicates any movement of the piston. This manometer has a range of about fifty grams per square-centimeter, hence the use of weights smaller than 50 grams is avoided.

Comparisons of the piston gage with the manometer, which were made before the present rotating device was used, give 1.3031 square centimeters at the effective area or 1.1302 centimeter as effective diameter at 25 degrees C., whereas direct measurements of the diameter of the piston give 1.1298 centimeters. The results of the comparison up to 15 atmospheres showed variations from the mean, due to both gages combined, corresponding to 1.5 mm. pressure. Further comparison at pressures above 15 atmospheres will be made.

The gage described in this paper was exhibited and operated by the authors at the close of the meeting.

Discussion.—The paper was discussed by Mr. WHITE.

S. J. MAUCHLY, *Recording Secretary.*

BOTANICAL SOCIETY OF WASHINGTON

143RD MEETING

The 143rd regular meeting of the Botanical Society of Washington was held at the Cosmos Club, 8 p.m., April 6, 1920. Sixty members and thirty-three guests were present.

Under "Brief Notes and Reviews of Literature," Mr. F. L. LEWTON exhibited three specimens of the fruit of a large leguminous tree, *Andira excelsa* HBK, known in Tabasco, Mexico, as "Macayo." The seeds contain a poisonous alkaloid. They are used locally as a vermifuge and purgative, but because of their poisonous nature, have been the subject of several articles sounding a warning against the careless use of them. The fruits are oval, 8–12 centimeters long, and grooved on one side with a roughened surface resembling the convolutions of the brain.

Prof. A. S. HITCHCOCK read an illustrated paper on *A botanical trip to British Guiana.* He stated that British Guiana has an area of about 90,000 square miles, extending back from the coast about 400 miles. The climate is strictly tropical, the temperature at Georgetown varying in summer from 82° at night to 88° in the day, and in winter from 78° to 84°, F. The rainfall at Georgetown averages about 90 inches, distributed somewhat vaguely into two wet and dry seasons. In the interior the distribution is nearly normal for Tropical America, the wet season being from April to August. The vegetation is characteristic of the

lowland tropics. Mangrove formations line the sea coast and extend up the rivers 30 miles or more. In the main the country is covered with forest, but the Venezuelan savannas extend across the southern part of the Colony.

Prof. Hitchcock collected all kinds of flowering plants, though special attention was given to the grasses. About 1100 numbers were obtained, including 108 sets of grasses. The trip was made under the auspices of the U. S. Department of Agriculture, the New York Botanical Garden, and the Gray Herbarium.

144TH MEETING

The 144th regular meeting of the Botanical Society of Washington was held at the Cosmos Club, 8 p.m., May 4, 1920. Thirty-two members and four guests were present.

Under "Brief Notes and Reviews of Literature," Dr. C. D. MARSH discussed the peculiar appearance of defoliated aspens which he had observed in the Wasatch Mountains. The trees had put out their foliage on certain branches, only producing dense clusters of very large leaves, which gave a "witches-broom" effect.

An illustrated paper on *The phytogeography of the Coeur d'Alene basin of northern Idaho* was read by Dr. H. B. HUMPHREY. He explained that in pre-miocene times that fork of the Columbia River draining the western slopes of the Bitter Root Mountains flowed northward through the Purcell trench. Eruptions of lava which crept up the valley obstructed the flow of the river, but through long-time erosion the stream reopened its channel and was probably active until the recent ice age. The retreating glaciers of the ice age left a dam of pleistocene gravel in the valley at the head of the present Coeur d'Alene Lake. The average elevation of this gravel dam is 2,155 feet above sea level. This deposit of gravel caused the Coeur d'Alene basin to fill and form a lake of great extent.

Ancient markings indicate that the surface elevation of this lake was approximately 2,135 feet above sea level, or approximately 20 feet lower than the crest of the gravel dam. This lake subsequently found an outlet through the present Spokane River.

Excessive deposition of silt brought down from the mountains resulted in the development of river banks throughout the length of the east and southeast arms of the lake. The seasonal inundations have gradually raised the floor of the basin. Aided by the accumulation of vegetable detritus, development of meadows followed. The filling-in process has progressed slowly, leaving at the upper reaches of the old lake arms a flood plain of highland meadows and typical mesophytic vegetation, which tapers off into lowland meadows and marshes followed by common hydrophytes such as Sparganium, *Acorus calamus*, *Equisetum fluviatile*, Sagittaria, etc., and finally by such plants as Potamogeton, Utricularia, Nymphaea, etc.

That the development of the present flood plain has taken place within relatively recent times is supported by the fact that the bottom of these tributaries of the Coeur d'Alene basin as far as investigated has been found to be cored by a deposit of almost pure diatomaceous sediment varying in depth from a few inches to several feet. The early development of river banks throughout the Coeur d'Alene and St. Joe arms of the lake furnished channels down which vast quantities of silt have been conveyed. Only at the height of the spring flood, therefore, is there an appreciable deposition over areas beyond the confines of the river banks. As a result the soil of the meadows is very largely composed of diatomaceous earth and muck in various stages of development.

In a short paper on *Plant pathology in Denmark in recent years*, Dr. F. KOLPIN RAVN, professor of plant pathology in the Royal Agricultural College of Denmark, Copenhagen, described the organization for investigational work in plant pathology provided for at the Royal College of Agriculture and Experiment Stations. The College also conducts winter schools and extension work. The plant inspection service is under a special commission which inspects and certifies plant products exported to foreign countries and acts as a judicial body in connection with a new system of seed certification which guarantees the purity and viability of practically all the seed sold in Denmark.

CHAS. E. CHAMBLISS, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

Mr. REEVES W. HART has recently resigned from the Leather Section of the Bureau of Standards, to become research chemist at the Benicia tannery of Kullman, Salz and Company, at Benicia, California.

Mr. MAYO D. HERSEY, chief of the Aeronautic Instrument Section of the Bureau of Standards, resigned in October to take the position of Associate Professor of Properties of Matter, in the department of physics of the Massachusetts Institute of Technology. He will be succeeded at the Bureau by Dr. F. L. HUNT.

Major LAWRENCE MARTIN, of the General Staff, U. S. Army, has been ordered to report to the Secretary of State for temporary duty to assist in preparing a report to the President on the proposed western boundaries of Armenia.

Mr. KENNETH P. MONROE has resigned from the color laboratory of the Bureau of Chemistry to accept a position at the Jackson Laboratory of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

Professor HARMON NORTHROP MORSE, professor of inorganic and analytical chemistry and director of the chemical laboratory of Johns Hopkins University, and a non-resident member of the ACADEMY, died on September 8, 1920, at Chebeague Island, Maine, in his seventy-second year. Professor Morse was born at Cambridge, Vermont, October 15, 1848. He became connected with Johns Hopkins University in 1876, shortly after completing his academic and scientific education at Amherst and at Göttingen, and was connected with the institution from that date until the time of his death. His publications covered a wide range of inorganic, analytical, and physico-chemical subjects, but his attention was particularly directed during recent years to the measurement and theory of osmotic pressures.

Dr. C. NUSBAUM, formerly of the Magnetic Section of the Bureau of Standards, has been appointed research associate in the Division of Industrial Research and Cooperation of the Massachusetts Institute of Technology.

Dr. P. V. WELLS is returning to the Bureau of Standards after completing his investigations on the stratification of thin soap films, which he has been carrying forward at the laboratory of Professor PERRIN in Paris. Dr. Wells attended the recent meeting of the British Association.